Advanced Journal of Graduate Research
ISSN:2456-7108
Volume 5, Issue 1, pp. 8-15, January 2019
DOI: https://doi.org/10.21467/ajgr.5.1.8-15

GRADUATE REVIEW ARTICLE

SiC Particulate Reinforced Aluminium Metal Matrix Composite

Murlidhar Patel[1*], Bhupendra Pardhi[1], Manoj Pal[1], Mukesh Kumar Singh[2]
[1] Department of Mechanical Engineering, Institute of Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh, India, 495009
[2] Department of Industrial and Production Engineering, Institute of Technology, Guru Ghasidas Vishwavidyalaya, Bilaspur, Chhattisgarh, India, 495009

*Corresponding Author email:
murlidharpatel4@gmail.com

Article History

Received: 6 June 2018
Accepted: 19 August 2018
Published: 10 September 2018

Student(s)

- Murlidhar Patel
- Bhupendra Pardhi
- Manoj Pal

Academic Year: 2017-18/2nd Semester
Course Level: Master
Course Name: M.Tech. (Machine Design)
Course year: 2nd year / 4th Semester

Mentor(s)

- Mukesh Kumar Singh

ABSTRACT

Al or Al alloy MMCs have wide range of application i.e. aerospace, automobile etc. due to its lightweight, high tensile strength, high wear resistance. This review paper characterized the SiC particulate reinforced Al MMCs. The SiC particulates are dispersed in Al or Al alloy by liquid state processing route and solid-state processing route. Stir casting liquid processing route has been followed by no. of researchers due to its simplicity and low processing cost and at the time of reinforcement small amount of Mg is added to increase the wettability of SiC in molten Al or Al alloy. When Al or Al alloy reinforced with SiC, then its mechanical and tribological properties are enhanced. The effect of particle size, weight or volume fraction of the SiC on density, porosity, hardness, impact toughness, tensile strength, ductility, sliding wear resistance, slurry erosion resistance, erosion-corrosion resistance, corrosion resistance and fatigue strength of Al or Al alloy MMCs are reported. The effect of extrusion and machinability of the SiC particulate reinforced AMMCs are also discussed in this review article.

Keyword: SiC, MMC, Composite, Density, Tensile strength, Matrix, Wear, Stir casting.

1 Introduction

Composite material is formed by the macroscopic combination of two or more materials [1]. It consists two chemically non-reactive phases namely reinforcing phase and matrix phase. The reinforcing phase always embedded in the matrix phase. The matrix phase always shares the load with reinforcing phase. Particles, fibers or flakes are used for reinforcing phase and polymers, metals or ceramics are used for matrix phase. The matrix phase of the composite material is generally ductile as compared to the reinforcing phase. On the basis of the matrix phase, composites may be classified into- Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs), Polymer Matrix Composites (PMCs) and Carbon Matrix Composite [2]. Based on types of reinforcement-Particulate Composites (composed of particles), Fibrous Composites (composed of fibers), and Laminate Composites (composed of laminates) [3]. The composites materials have some advantages over conventional materials, which make then applicable in many areas. Composite has no. of properties as compared to the conventional materials i.e. lightweight, high specific stiffness and strength, easy mouldable to complex forms, easy bondable, good dumping, low electrical conductivity and thermal expansion, good fatigue resistance, part consolidation due to lower overall system costs, low radar visibility, internal energy storage and release [4]. In particulate metal matrix composite, the reinforcing phase is particles (generally ceramic particles) and the matrix phase is metal. Al and its alloys are mainly used for developing metal matrix composite. Al metal matrix composites have wide range of application i.e. aerospace, biotechnology, automotive, electronic, nuclear and sports industries [5]. Aluminium and its alloy-based metal matrix composites (MMCs) are "engineered materials" for automobile, aerospace etc. The additions non-metallic material i.e. SiC, B_4C flyash etc. can enhanced the mechanical and tribological properties of the base Al or its alloy matrix. The Al or Al alloy MMCs also have enhanced physical properties i.e. higher modulus, lower coefficient of thermal expansion of the base matrix. Over the last decade, low-cost particulate reinforcements i.e. SiC, $A1_2O_3$, fly ash and graphite have been used to reduce the cost of Al or Al alloy MMCs. At present, there has been significant progress in the development of low-cost processing technique [6].

2 Effect of SiC Reinforcement on the Mechanical Properties of Al or Al Alloy

Cocen and Onel [7] have investigated the ductility and strength of extruded SiC-p/aluminium-alloy composites. In this work Al-5Si-0.2Mg reinforced with 9, 13, 17, 22 and 26 vol. % of SiC-p (15-30μm) by melt stirring technique and extruded at 500˚C at an extrusion ratio of 10:1. By the application of extrusion; disappear the cluster of SiC particles, reduce the porosity of the composite to very low levels and the yield strength & the tensile strength values are improved by approximately 40%. The ductility of the as-cast composites is decreased with the increasing amounts of SiC-p, but by the application of extrusion, a substantial improvement in ductility is obtained due to reduction in the porosity. They found yield strength and tensile strength of the as-cast composites increase with the volume fraction SiC-p upto 17% and then decrease with further additions of reinforcement. In extruded composite, the yield and the tensile strength increase continuously with the volume fraction of reinforcement. Sahin [8] has studied about the preparation and analysis of mechanical properties of SiC-p reinforced AMMCs. He developed composites by AA2014 reinforced with SiC-p (10 and 20 wt. % and size of 29μm, 45μm and 110μm) from squeeze casting technique. They analysed the effect on density, porosity and hardness. To minimize porosity of the Al-MMCs, 3000kg of force by the hydraulic press was applied for 7min mechanically before taken from the mould. After that the mould was taken from the press to cool down for 20min approx. He observed the density decreased with decreasing particle sizes, but porosity and hardness decreased considerably with increasing particle size. Hardness, porosity and density of composites are increases when wt. % of reinforcement increases. The homogenous distribution of SiC particles are obtained in the composite with particle size of 110μm when compared with another particle size (45μm and 29μm) reinforced composites, some agglomeration is observed when particle size is less than 110μm. The functionally graded centrifugal cast Al-SiC-p MMCs manufactured and characterized by El-Galy et al. [9]. SiC-p with different weight fractions (0%, 2.5%, 5%, 7.5%, 10% and 15%) and three different particle sizes of 16μm, 23μm and 500μm has investigated. Three rotational speeds of 800rpm, 900rpm or 1000rpm and two controlled linear speeds of 16mm/s or 28mm/s have been used for feeding the metal along the tube axis. The cast tubes have SiC particles concentrations and hardness in the outer zone reach its maximum value and followed by a gradual decrease in concentrations and hardness in the direction of inner diameter. With increase in weight fraction of SiC-p, proportionally increase in outer zone hardness but beyond 10 wt. % SiC-p the increasing rate is decreases slightly. When increasing the weight fraction of SiC-p then tensile strength increases but ductility decreases. They found that the ultimate tensile strength is proportional to the percentage of SiC-p and inversely proportional to the size of the particles. The tensile strength is increases linear up to 10 wt. % SiC-p and the increase rate is lower afterwards up to 15 wt. % SiC-p. Venkataraman and Sundararajan [10] have analysed the tensile strength of SiC-p reinforced Al MMCs and they also found that the tensile strength increases but tensile density decreases when the volume fraction of SiC is increasing in Al matrix. Ozben et al. [11] have examined the mechanical and machinability properties like density, hardness, impact

Patel *et al., Adv. J. Grad. Res.;* Vol. 5, Issue 1, pp: 8-15, January 2019

toughness, tensile strength and machinability characteristics of AlSi7Mg2 reinforced with 5, 10 and 15 wt.% of SiC-p (30-60 μm). 2% of Mg is added in Al7Si alloy to increase the wettability of reinforcements. In particles size range (30-60μm), the ratio of 50–60 μm particles kept lower than the ratio of 30-45μm particles. The reason for using different sized particles is that small particles at a higher ratio help to increase strength and bigger particles support to gain a homogeneous mixture. According to their investigation hardness and density of MMCs increased when increase in reinforcement ratio, but impact toughness decreased. They also find tensile strength increased upto 10 wt. % of SiC-p reinforced and decreased when 15 wt. % of SiC-p reinforcement used. When increase in feed rate value or particle ratio then surface roughness and wear of cutting tool increased. Surface quality improved in turning of AlSi7Mg2-MMC samples when cutting speed decreased. Rao et al. [12] have done an experimental investigation on mechanical properties of Al7075/SiC-p composites and they found that by increasing SiC particle size and wt. % considerably enhanced the tensile strength and hardness of the composites but the ductility of the composite is decreased. Ozden et al. [13] have investigated the impact behaviour at different temperature i.e. -176˚C, 21˚C, 100˚C, 200˚C and 300˚C of aluminium alloy (2124, 5083 and 6063 Al alloy) with SiC-p (167μm and 511μm) reinforced MMCs with hot extrusion ratio of 13.63:1 and 19.63:1. They observed SiC-p as reinforcement in a ductile matrix of Al alloys decreased the impact toughness of matrix. The impact toughness of the composites slightly improved with increased particle size and the hot extrusion ratio, but artificial ageing decreased the impact toughness of all unreinforced alloys and the composites. The test temperature were not affected the impact behaviour of unreinforced AA5083 and AA5083-SiC-p composite. Around 100˚C, the impact strength of the composites based on AA2124 and AA6063 alloys are decrease. Meena et al. [14] have analysed the mechanical properties of the developed Al/SiC MMC's by stir casting process in which AA6063 reinforced with SiC particulates (weight fraction of 5, 10, 15 and 20%) with mesh size of 220, 300 and 400. They observed proportionality limit, tensile strength upper yield point, tensile strength lower yield point, ultimate tensile strength, breaking strength, hardness and density increases with the increase in reinforced particulate size (220 mesh, 300 mesh, 400 mesh) and weight fraction (5%, 10%, 15% and 20%) of SiC particles, but % elongation and % reduction in area decreases with the increase in reinforced particulate size and weight fraction of SiC particles. Impact strength decreases with the increase in reinforced particulate size and increases with the increase in weight fraction of SiC particles.

3 Effect of SiC Reinforcement on the Abrasive and Sliding Wear Properties of Al or Al Alloy MMC

Karamis et al. [15] have analysed the failure and tribological behaviour of the AA5083 and AA6063 composites reinforced by SiC particles under ballistic impact. The wear behaviour of AA5083 and AA6063 reinforced by 15, 30 and 45 vol.% SiC-p (250-500μm) composites fabricated by squeeze casting are investigated under condition of high-velocity (710m/s) impact by firing 7.62mm armour piercing rounds into these composite materials specimens of disc-shaped with a diameter of 140mm and a thickness of 20mm. By the use of SEM and optical microscopy wear and failure mechanisms of projectile tips and hole surfaces produced by high-velocity impact are evaluated. Terminal ballistic tests performed and find depth of the projectile penetration reduced if the friction between the projectile and MMC armour is increases due to the projectile comes into contact with more reinforcement particles or If the particles are brittle then sometimes broken up into smaller pieces and buried into the frictional surfaces. When projectile impacts on the MMC armour then projectile nose is plastically deformed, because of swelling and the presence of SiC particles in the matrix. The predominant wear mechanisms are three or two-body abrasion as a result of the frictional conditions and melt wear generated from higher friction and then re-solidified over the sliding (frictional) surfaces when cooled down. The cracks observed on hole surfaces caused by rapid plastic deformation and solidification but these cracks do not propagate to the subsurface. In the matrix, compacted zone is observed near the surface which is highly deformed due to impact of projectile. The hardness distribution is different in compacted zone from the matrix. Uzkut [16] has investigated the abrasive wear behaviour of AA2011 reinforced with SiC-p (avg. particle size 64μm) volume fractions of 7, 14 and 21%. Composites were fabricated by vortex method. He observed the wear resistance of the AA2011 composites was higher than the unreinforced AA2011. The increase in sliding distance, wear volume loss of the AA2011 increased. When increase in SiC particles content, the wear resistance of the AA2011 composites increased but decreased with the increasing abrasive grit size of the emery used. Venkataraman and Sundararajan [10] have analysed the sliding wear rate and the coefficient of friction of SiC particulate (avg. size of 2.5μm and vol. fraction of 10, 20, 30 and 40%) reinforced Al (30-40μm) matrix composites fabricated by powder metallurgy technique. They found the wear resistance of Al matrix composite is superior to the Al, when it reinforced with the SiC particles. Wear resistance increases with increasing volume fraction of SiC, but the corresponding effect on coefficient of friction is only marginal. The coefficient of friction of the Al-SiC composite is higher than that of Al at both the test loads of 52N and 122N with sliding velocity 1m/s. El-Galy et al. [9] have found in the range 7.5-10 wt. % SiC-p, maximum improvement of wear resistance could be achieved. The wear resistance of the 23μm particles size SiC-p reinforced AMMC shows that the highest wear resistance. Idrisi and Mourad [17] have studied on the fabrication and wear analysis of aluminium matrix composite reinforced by SiC micro and nano particles. AA5083 matrix composites reinforced with micro (5 and 10 wt. %) and nano (1 and 2 wt. %) SiC-p have been fabricated by use of stir casting process. For performing wear analysis, these composites are used for manufacturing of gears through milling operation. Wear test of gears were performed at different loads (10N, 20N, and 30N) for different time (30mins, 60mins, 90mins and 120mins) and found that wear increase with increase in load and time. AA5083 reinforced with 2 wt. % nano SiC-p composite gear shows the highest wear resistance among the all tested composition. At 10N, AA5083 with 10 wt. % of micro SiC-p demonstrated more wear resistance as compared to AA5083 with 1 wt. % nano SiC. On the other hand, AA5083 with 1 wt. % nano SiC shows more wear resistance as compared to AA5083 with 10 wt. % of micro SiC at 30N. At 20N both composite shows comparatively same wear resistance. Manivannan et al. [18] have also studied about the tribological and surface behaviour of silicon carbide reinforced aluminium matrix nan composite in which AA6061 matrix reinforced with 1.2% nano SiC-p (average particle size of 50nm) by using ultrasonic cavitation assisted stir casting. They noted that the hardness of the AA6061- 1.2 wt. % nano SiC-p composite is 73% increase as compare to AA6061. The AA6061-1.2 wt. % nano SiC-p composite have superior wear resistance at the higher applied load. At all applied load, the COF of nanocomposite were lower than those of the unreinforced alloy. Erturk et al. [19] have analysed the tribological behaviour of SiC particulate reinforced AA5754 matrix composite under dry and lubricated conditions. AA5754 matrix reinforced 10 wt. % SiC particulates (particles size of 44μm) composite fabricated by squeeze casting technique and their tribological behaviour investigated by using a pin on disc tribometer. They observed the wear properties of the AA5754 alloy were considerably improved by the addition of SiC particles into it. The weight losses of tested materials are linearly increased with increase in sliding distance. To study the wear assessment using optical methods, the material surfaces before and after the wear tests were examined and found that adhesive and abrasive forms of wear were present. Pradhan et al. [20] have also investigated the tribological behaviour of Al-SiC particulate metal matrix composite under dry, aqueous and alkaline medium. In this study aluminium alloy LM6 reinforced with 7.5 wt. % of SiC particles (400 mesh size = 37μm) by using the liquid stir casting process. They found that wear increases with increase in applied load and sliding speed under all conditions (dry, aqueous and alkaline environments) but wear is maximum in alkaline environment followed by aqueous medium and dry sliding. COF decreases with increase in applied normal load. The COF remains low in alkaline solution compared to the other environments due to the lubrication effect of the alkaline solution. Pradhan et al. [21] have investigated the effect of SiC-p weight percentage on tribological properties of Al-SiC particulate metal matrix composites under acid environment. In this analysis Al LM6 reinforced with different weight percentages of SiC-p (5 wt. %, 7.5 wt. % and 10 wt. %) composites are fabricated through the liquid stir casting method. They found that wear increases with increase in applied load and sliding speed, but the COF decreases with increase in load and increase in wt. % SiC-p and slightly fluctuates with variation of sliding speed. From microstructure analysis it is found that adhesive, abrasive and corrosive wear mechanisms are present for

removal of material from the Al-SiC-p MMCs. Wear resistance of the composites are increased with the increase in wt. % of SiC particles in Al. Rao et al. [12] have done an experimental investigation on wear properties of Al7075/SiC-p composites. AA7075 reinforced with SiC-p (particle size of 25µm, 50µm and 75µm and particulate content 5, 10 and 15wt. %) composites are manufactured by using stir casting technique. The effect of SiC-p contents and particles size on the microstructural, mechanical properties and wear rate of the composites was studied. The dispersion of SiC particulates reinforced into the matrix alloy are examined by the use of SEM and found with reasonably uniform with minimal particle agglomerations and with good interfacial bonding between the particles and matrix material. By XRD analysis the presence of Al and SiC within the composite is confirmed. Wear resistance was increased with increase in particles size and wt.% in AA7075 up to 1200m of sliding distance for all the composites, whereas for the composite containing 75µm SiC-p it was extended up to 1800m. Sadagopan et al. [22] have invented silicon carbide reinforced aluminium matrix composite for brake rotor of motorcycle. They discussed about the design, thermal and structural analysis & the mechanical and thermal characteristics of SiC-p (20%) reinforced aluminium (AA6061) matrix composite. Composite were fabricated by stir casting route for motorcycle brake rotor. Wear tests are done for SiC-p reinforced AMMC and cast-iron pins by using pin on disc wear test machine and found that SiC-p reinforced AMMC has an edge over cast iron for brake rotor application. It was observed that in terms of braking distance and heat dissipation, the SiC-p reinforced AMMC rotor has better efficiency in comparison with cast iron rotor. The risk of brake fade reduced due to higher heat dissipation of SiC-p reinforced AMMC. The weight of the fabricated AMMC rotor is 56% less than that of the cast iron rotor.

4 Effect of SiC Reinforcement on the Erosion, Corrosion and Erosive Corrosive Wear Properties of Al or Al Alloy MMC

For engineering applications; Das [23] has developed aluminium alloy composites by using stir-casting technique in which Al-Si (BS: LM13) reinforced with 10 wt. % and 15 wt. % SiC-p of size 50-80µm. He found that the erosive-corrosive wear rate of the composite is less than that of the alloy. In all tribo-conditions aluminium composite provides higher wear resistance than those of the base alloys. Composite exhibits more or less wear rate to that of base alloy beyond a critical load and abrasive size, wear rate with the applied load increases almost linearly. As compared to the alloy, frictional heating and coefficient of friction are considerably less in composite. Under both dry and lubricated sliding wear composites exhibit improved wear resistance and seizure pressure as compared to the alloy. Kumar et al. [24] have analysed influence of corrosion-erosion wear in slurry (made up of alumina of size 90-150µm and proportion of 10, 20 and 30 wt.%, while normality of H_2SO_4 is 0.01N, 0.1N and 1N was added to create the corrosive conditions) on AA6061/SiC metal matrix composites (MMC's) by using Taguchi technique. In corrosive-erosive wear test the weight % of abrasive particles in slurry is the major factor which influence on the wear rate (57.52%) followed normality of H_2SO_4 in slurry (31.46%) and reinforcement (3.04%). Around the dispersoid / matrix interfacial region cracking tendency of the composites is observed. Ramachandra and Radhakrishna [25] have investigated the sliding wear, slurry erosive wear, and corrosive wear of aluminium alloy (Si-7.2%) LM25 reinforced with SiC particulates (0, 5, 10, 15 wt. %) by conventional vortex casting technique. They were found that with the addition of SiC particles, the sliding wear and slurry erosive wear resistance improved considerably. The formation of a passive layer in slurry erosive wear retarded the wear of the material. Corrosion resistance decreased with the addition of SiC particles as compare to the alloy matrix. They observed that pitting corrosion was the dominant mechanism. By the microscopic examinations of the wear debris, worn surfaces and subsurface they found that the base alloy wears primarily due to micro-cutting and MMCs wear due to micro-cutting, plastic deformation, oxidation, and thermal softening. The bulk hardness increased with an increase in the percentage of SiC particulates in Al alloy matrix. The density of MMCs was not much change as compared to the base metal.

5 Effect of SiC Reinforcement on the Fatigue, Thermal and other Properties of Al or Al Alloy MMC

Murty et al. [25] have studied on the hot working characteristics of 6061Al-SiC particulate reinforced metal matrix composites and in the processing, maps delineating the unstable regions. They verified the stable and unstable regions in the map by the microstructural observations of the deformed compression specimens. They observed from the processing maps, when increase in volume fraction of the SiC particles then domain of instability increases. Lloyd et al. [27] have studied on microstructural aspects of Al-SiC particulate composites produced by a casting method. They analysed the effect of solidification rate and silicon content in Al alloy matrix. They observed Al alloy with high silicon content matrix has low reactivity of SiC particles in the molten matrix, so composite will have high resistance to formation of Al_4C_3. The reaction product Al_4C_3 at the interface between the SiC-p and the Al alloy, reduce the reinforcement strength and the interfacial strength, increases the corrosion susceptibility of the alloy and increases the silicon content of the alloy. The higher solidification rate results more uniform distribution of SiC in the matrix, because the SiC is situated in the interdendritic regions. Razaghian et al. [28] have worked on the fracture behaviour of a SiC particulate reinforced aluminium alloy at high temperature. They study about the effect of temperature on tensile strength and fracture behaviour of AA7075 reinforced with 15 vol.% of SiC particles (avg. size of 14μm) under uniaxial tensile loading, at temperature (25˚C, 250˚C, 300˚C, 350˚C and 400˚C) and strain rate $10^{-3}s^{-1}$. They observed particle fracture (region of large particle and clustered particles) is the main damage prior to final fracture at room temperature, but at high temperature; interface debonding together with inter-particle voiding (voids nucleated in matrix closely adjacent particles and particle ends) is dominant. At the room temperature unreinforced alloy has high tensile strength as compared to reinforced Al alloy, but low strength above 250˚C. The strength level of AA7075 and its composite exhibited similar above the 300˚C. At all temperatures the ductility of monolithic alloy higher than composite materials. Gupta and Nai [29] have fabricated AA1050/SiC-p (avg. particles size 34.4μm and 18 wt. %) functionally gradient materials (FGMs) by an innovative process, termed here as the gradient slurry disintegration and deposition (GSDD) process. They noted that the value of the coefficient of thermal expansion (CTE) at the high SiC-p end was found to be lower, as compared to the low SiC-p end. Chen and Tokaji [30] have investigated the effects of particle size on fatigue crack initiation and small crack growth in SiC particulate-reinforced aluminium alloy composites. For the analysis; AA2024 matrix reinforced with 10 wt. % SiC particulates of three different sizes of 5μm, 20μm and 60μm by powder metallurgy technique and fully reversed axial fatigue tests and tensile test were performed. They observed 60μm SiC-p/AA2024 composite showed significantly lower fatigue strength (due to its inferior crack initiation resistance which attributes to interface debonding between matrix and particles) as compare to 5μm and 20μm SiC-p/AA2024 composites which have same fatigue strength as the unreinforced alloy. With the addition of SiC particles, the crack initiation resistance was reduced, and it also tends to decrease with increasing particle size. Crack growth resistance at low applied stress increased with increasing particle size, while at high applied stress, the 5μm and 20μm SiC-p/AA2024 composites showed higher growth resistance than the unreinforced alloy, but the 60μm SiC-p reinforced AA2024 composite exhibited considerably low resistance that was attributed to interaction and coalescence of multiple cracks. With the addition of SiC particles, proof stress is slightly decreased, but no effect of particle size on it. The tensile strength increases with the presence of SiC particles except for the 60 μm SiC-p/AA2024 composite. Elongation and reduction of area of all the composites decrease significantly when compared with the unreinforced alloy, but the particle size dependence cannot be seen. The modulus of elasticity for all the composites is almost the same and upto 17% increase with respect to the unreinforced alloy.

6 Conclusion

This review paper focused on the characterization of mechanical, tribological and corrosion behaviour of SiC particulate reinforced Al MMCs. When the SiC content in the Al matrix increases then density, hardness, tensile strength, sliding wear resistance and slurry erosive wear resistance of the composite are increase but ductility, impact toughness and coefficient of friction of the composite are decreases. If the particle size of the SiC is increasing then the density, porosity, hardness, tensile strength, impact toughness, sliding wear resistance, slurry erosive wear resistance of the composite are increases but the ductility and fatigue strength decreases. SiC particulate reinforced Al MMCs have higher slurry erosion and erosive-corrosive wear resistance as compared to base matrix, but its corrosion resistance is lower than the base matrix. Density and impact toughness of the Al MMCs are improved by extrusion but porosity and cluster of SiC particles in the composite are decreases. At the time of machining, tool wear increases with increase in feed rate. Improved surface quality obtained at low cutting speed. Tensile strength, hardness and wear resistance increase linearly upto 10wt. % SiC reinforcement. Nano SiC particulate reinforced Al MMCs have high tensile strength as compared to micro SiC reinforced Al MMCs. Max. wear in SiC-p reinforced Al MMCs is obtained at alkaline environment followed by aqueous and dry environment.

How to Cite this Article:

{will be updated in the final version}

References

[1]. R. M. Jones, *Mechanics of composite materials*, Second Edi. CRC press, 1998.

[2]. A. K. Kaw, *Mechanics of composite materials*. CRC press, 2006.

[3]. J. Fan and J. Njuguna, "An introduction to lightweight composite materials and their use in transport structures," *Light. Compos. Struct. Transp.*, pp. 3–34, 2016.

[4]. P. P. Adrian and B. M. Gheorghe, "Manufacturing process and applications of composite materials," *Fascicle Manag. Technol. Eng.*, vol. 9, no. 19, pp. 3.1-3.6, 2010.

[5]. P. O. Babalola, C. A. Bolu, A. O. Inegbenebor, and K. M. Odunfa, "Development of aluminium matrix composites : A review," *Online Int. J. Eng. Technol. Res.*, vol. 2, pp. 1–11, 2014.

[6]. G. S. Cole and A. M. Sherman, "Lightweight materials for automotive applications," *Mater. Charact.*, vol. 35, pp. 3–9, 1995.

[7]. U. Cocen and K. Onel, "Ductility and strength of extruded SiCp/aluminium-alloy composites," *Compos. Sci. Technol.*, vol. 62, pp. 275–282, 2002.

[8]. Y. Sahin, "Preparation and some properties of SiC particle reinforced aluminium alloy composites," *Mater. Des.*, vol. 24, pp. 671–679, 2003.

[9]. I. M. El-Galy, M. H. Ahmed, and B. I. Bassiouny, "Characterization of functionally graded Al-SiCp metal matrix composites manufactured by centrifugal casting," *Alexandria Eng. J.*, 2017.

[10]. B. Venkataraman and G. Sundararajan, "The sliding wear behaviour of Al-SiC particulate composites-I. Macrobehaviour," *Acta Mater.*, vol. 44, no. 2, pp. 451–460, 1996.

[11]. T. Ozben, E. Kilickap, and C. Orhan, "Investigation of mechanical and machinability properties of SiC particle reinforced Al-MMC," *J. Mater. Process. Technol.*, vol. 198, pp. 220–225, 2008.

[12]. T. B. Rao, "An experimental investigation on mechanical and wear properties of Al7075/SiCp composites: effect of SiC content and particle size," *J. Tribol.*, 2017.

[13]. S. Ozden, R. Ekici, and F. Nair, "Investigation of impact behaviour of aluminium based SiC particle reinforced metal–matrix composites," *Compos. Part A Appl. Sci. Manuf.*, vol. 38, pp. 484–494, 2007.

[14]. K. L. Meena, A. Manna, and S. S. Banwait, "An analysis of mechanical properties of the developed Al/SiC-MMC's," *Am. J. Mech. Eng.*, vol. 1, no. 1, pp. 14–19, 2013.

[15]. M. B. Karamis, A. Tasdemirci, and F. Nair, "Failure and tribological behaviour of the AA5083 and AA6063 composites reinforced by SiC particles under ballistic impact," *Compos. Part A Appl. Sci. Manuf.*, vol. 34, pp. 217–226, 2003.

[16]. M. Uzkut, "Abrasive wear behaviour of SiCp-reinforced 2011 Al-alloy composites," *Mater. Technol.*, vol. 47, no. 5, pp. 635–638, 2013.

[17]. A. H. Idrisi and A. I. Mourad, "Fabrication and wear analysis of aluminium matrix composite reinforced by SiC micro and nano particles," in *Proceedings of the ASME 2017 Pressure Vessels and Piping Conference*, 2017, pp. 1–8.

[18]. I. Manivannan, S. Ranganathan, S. Gopalakannan, S. Suresh, K. Nagakarthigan, and R. Jubendradass, "Tribological and surface behavior of silicon carbide reinforced aluminum matrix nanocomposite," *Surfaces and Interfaces*, 2017.

[19]. A. T. Erturk, M. Sahin, and M. Aras, "Tribological behavior of SiC particulate reinforced AA5754 matrix composite under dry and lubricated conditions," *Trans. Indian Inst. Met.*, 2016.

[20]. S. Pradhan, S. Ghosh, T. K. Barman, and P. Sahoo, "Tribological behavior of Al-SiC metal matrix composite under dry , aqueous and alkaline medium," *Silicon*, 2017.

[21]. S. Pradhan, T. K. Barman, P. Sahoo, and G. Sutradhar, "Effect of SiC weight percentage on tribological properties of Al-SiC metal matrix composites under acid environment," *J. Tribol.*, vol. 13, pp. 21–35, 2017.

[22]. P. Sadagopan, H. K. Natarajan, and P. K. J, "Study of silicon carbide-reinforced aluminum matrix composite brake rotor for motorcycle application," *Int J Adv Manuf Technol*, 2017.

[23]. S. Das, "Development of aluminium alloy composites for engineering applications," *Trans. Indian Inst. Met.*, vol. 57, no. 4, pp. 325–334, 2004.

[24]. S. M. S. Kumar, K. P. Rao, and D. P. Girish, "Corrosion-erosion wear analysis of Al/SiC metal matrix composites by taguchi's technique," *Int. J. Adv. Eng. Technol.*, vol. 4, no. 1, pp. 23–26, 2013.

[25]. M. Ramachandra and K. Radhakrishna, "Sliding wear, slurry erosive wear, and corrosive wear of aluminium/SiC composite," *Mater. Sci.*, vol. 24, no. 2/1, pp. 333–349, 2006.
[26]. S. V. S. N. Murty, B. N. Rao, and B. P. Kashyap, "On the hot working characteristics of 6061Al-SiC and 6061-Al2O3 particulate reinforced metal matrix composites," *Compos. Sci. Technol.*, vol. 63, pp. 119–135, 2003.
[27]. D. J. Lloyd, H. Lagace, A. McLeod, and P. L. Morris, "Microstructural aspects of aluminium-silicon carbide particulate composites produced by a casting method," *Mater. Sci. Eng. A*, vol. 107, pp. 73–80, 1989.
[28]. A. Razaghian, D. Yu, and T. Chandra, "Fracture behaviour of a SiC-particulate-reinforced aluminium alloy at high temperature," *Compos. Sci. Technol.*, vol. 58, pp. 293–298, 1998.
[29]. S. M. L. Nai and M. Gupta, "Synthesis and characterization of free standing , bulk Al/SiCp functionally gradient materials : effects of different stirrer geometries," *Mater. Res. Bull.*, vol. 38, pp. 1573–1589, 2003.
[30]. Z. Z. Chen and K. Tokaji, "Effects of particle size on fatigue crack initiation and small crack growth in SiC particulate-reinforced aluminium alloy composites," *Mater. Lett.*, vol. 58, pp. 2314–2321, 2004.